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Liquidity Risk Management in the Portuguese Banking System

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A Project carried out under the supervision of Professor João Pedro Pereira

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Abstract

In the light of the recent financial crisis and interbank market turmoil, this study seeks to comprehend the determinants of Portuguese banks' liquidity management decisions. Based on data from 2005 to 2015, it is found that profitability, efficiency and size are the main drivers of a more aggressive risk-taking policy. Moreover, it is shown that the agent's optimal strategies relied more significantly on peers' choices, rather than on own individual fundamental characteristics and performance. Against this background, there is evidence for herding in liquidity management practices in the Portuguese banking industry in the period that preceded the sovereign crisis.

Key words: financial crisis; liquidity risk management; Portuguese banking; herding.

Contents

1 Introduction

Transforming liquid liabilities into illiquid assets demands a sensitive equilibrium between the mismatch in maturities that is often managed by banks at an interbank market level. The global crisis of 2007 exposed crucial weaknesses in the risk decisions and practices of financial institutions worldwide and emphasised the importance of efficiently operating money markets. The scarce liquidity flow in these funding channels that shaped the period from 2007-2009 significantly harmed banks' ability to respond to their short-term liquidity obligations.

Across the board, banks were showing signs of excessive dependence on wholesale funding. The shake in investors' confidence demanded them to re-evaluate their perception of the underlying risk associated with the way these institutions were handling the liquidity gaps intrinsic to their transformation function. The amount of risk that was before tolerated and perceived as a common practice of the industry, started to be repriced at a much higher cost. Ultimately, this context led to a freeze in these funds' negotiations. The consequences rapidly affected the real economy, which boosted the difficulties to implement the needed adjustments to overcome the negative cycle.

The Portuguese case was particularly challenging since it combined a highly-leveraged banking system with deep imbalances in the public-sector accounts. In fact, from 2007 onwards, and since deposits did not rise enough to compensate for the surge in banks' assets, the growth rate of wholesale funding increased at a much faster pace in Portugal, when compared to the Euro Area[1]. When the crisis burst, these factors significantly aggravated the willingness of investors to continue on funding these institutions, and created the need for drastic adjustments in the liquidity strategies that were being implemented until date.

[1] Based on data provided by the Portuguese Banking Association

The study starts with the analysis of the evolution of key financial and banking indicators from both pre and post crisis periods. To fully understand the development of the various metrics across the industry players, a fictional-representative bank was built based on the data gathered from the Annual Report and Accounts of 7 Portuguese banks, respectively proportional to their yearly weight on the total value of the assets for the industry.

The main contribution of this thesis to the literature is to comprehend what were the main determinants of Portuguese banks' liquidity management decisions during the period of 2005 until 2015. Moreover, the focus relies on understanding whether these institutions optimized their liquidity strategies solely based on their own individual characteristics or if, instead, there is statistical evidence to believe that there were collective risk-taking practices in the industry.

The empirical results regarding the drivers of liquidity management are derived from two different approaches: the construction of an econometric model and the implementation of the Lakonishok, Sheifer and Vishny (LSV) measure for herding. According to the findings, it is possible to confirm that Portuguese banks not only considered their size, profitability and efficiency, but also integrated each other's strategies while shaping their own. As a result, these ultimately reached a non-optimal point, neither from an individual nor from a collective perspective.

2 Literature Review

Given its underlying complexity, the concept of liquidity risk and the appropriate means of measuring it are not straightforward. Such as Bonfim and Kim (2012) described, it can be defined as the risk of losing access to funding, whether by failing to capture deposits or inability to refinance the current outstanding positions. In the past years, the finance industry has experienced a significantly increased interaction among financial institutions, a factor that has played a key role in the strengthening of wholesale funding across the board.

As discussed by Huang and Ratnovski (2011), this funds' channel not only acts as an efficient mean of seizing profitable investment opportunities and leveraging businesses at competitive prices, but also opens room for excessive exploitation. The Portuguese banking system successfully illustrates a case of progressively increased dependence on wholesale funding, with a significant intensification registered on the period beginning in 2006 and finally reaching its peak in 2011.

The dramatic drying of funds experienced by the Portuguese banking system in the latest financial crisis clearly illustrated the need to enhance regulatory requirements in this spectrum. As discussed in Bonfim and Kim (2012), there is the need for regulation to ensure that banks, in their role of liquidity providers, manage their own liquidity risk adequately. To do so, holding a set of highly liquid assets to cover any harmful mismatch between maturities at a given period seems to be the most reasonable solution. There is a trade-off, though, between holding such safe buffers. If, on the one hand, these ensure the sustainability of the liquidity flow through the economy by protecting it, they also imply the opportunity cost of not being injected back to the real economy to foster further growth and, for the banks' perspective, yield a higher return. There is, therefore, an intrinsic underlying tendency to deviate from this socially desirable equilibrium.

As financial transactions become more complex and banks increase their degree of interdependence amongst each other, the question on whether they incorporate each other's actions while optimizing their own strategies becomes relevant. Various authors, such as Farhi and Tirole (2012) or Rochet (2004), discuss the empirical findings on the enhanced incentives to engage in collective risk taking actions. As a matter of fact, evidence shows that banks are encouraged to engage in excessive liquidity risk when faced with a significant likelihood that authorities will use all available mechanisms to avoid a collective collapse, should they become unable to meet their obligations in the process. In order to contain the

damage and avoid a severe destruction of value, the so called “lender of last resort” would undertake a collective bailout. Hence, what should conceptually be a predominantly individual exercise turns out to be far more collective than what would be the desirable from a macroeconomic point of view. With regards to this matter, Ratnovski (2009) also supports that, under equilibrium conditions, this collective excessive risk taking is perceived by banks as a method to increase profitability free from the negative costs associated with its failure.

In the light of these findings and backed by the severe externalities of the most recent financial crisis, regulators have indeed been implementing increasing efforts to monitor institutions’ practices in their liquidity risk management, as it is the example of the Basel III reforms and the introduced liquidity ratios requirements. Although the regulation continues on being mainly focused on microprudential monitoring, it allows for greater prevention of macroprudential worries. For example, the Liquidity Coverage Ratio (LCR) introduced a 30-day period where banks are able to fully function in case of inability to access market funding and, on the other hand, the Net Stable Funding Ratio (NSFR) diminishes the risk of excessive reliance on short-term funding, thus compelling banks to re-organize and solidify their funding structure.

The comprehension of liquidity risk management for each institution relies greatly on understating which are the main factors – individual and collective – that influence it. One of the main methods followed to analyse this topic was the construction of an econometric approach that sought to model the evolution of institution’s choices.

There are other proposed models in the literature that address collective risk taking among industries, the so called herding behaviour. An agent is considered to be herding when it deviates its actions – or, more specifically, its rational actions given the available market information – after it observes its peers' decisions. Lakonishok, Sheifer and Vishny (1992) proposed the LSV measure – with an initial direct application to financial markets and,

mainly, stock analysis – focused on identifying herding behaviours across agents. In practical terms, this approach is based on the study of the gap between the proportion of decisions taken in a certain direction, compared to the expected proportion under the assumption of a no-herding scenario.

At an international spectrum, on a study conducted by Bonfim and Kim (2012) and focused on European and North American banks, the ratio between loans and assets, size and profitability were the most relevant variables explaining a riskier attitude towards risk.

3 The Context of the Portuguese Case

3.1. Evolution of Liquidity Management Practices before the Financial Crisis

The periods prior to the most severe years of financial distress in Portugal (in this study considered to be from 2000 until 2010, the year prior to the Portuguese official ask for external aid) were shaped by an unprecedented growth in some of the key performance indicators (KPI) of the Portuguese banking system. At the same time, the performance of the economy was beginning to show lack of conditions to support such developments. As it is possible to see in Chart 1 below, the Portuguese Current Account was persistently negative, showing signs of aggravation from 2003 onwards. The shown deficit could be perceived as the outcome of an investment-period. However, this was not being directly reflected on an increase in the value creation in the economy. On the other hand, other economies such as the German, seemed to have experienced a GDP growth that, until 2009, followed roughly the same path as the Portuguese, but was accompanied by a continuous position as a net creditor to the external sector.

As far as the KPIs for the banking institutions are concerned, the outlook is rather similar. According to data collected from the Annual Report and Accounts of 7 Portuguese banks, the

value of the assets of a representative institution, used as a proxy to the evolution of its size, increased by about 134% from 2000 to 2010 [2].

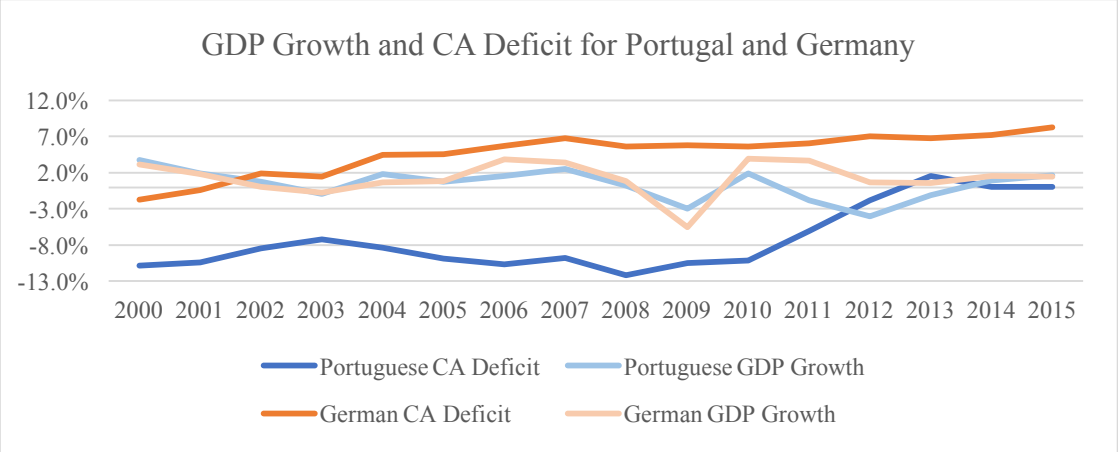

Chart 1 - Evolution of CA Deficit and GDP Growth for Portugal and Germany from 2000 to 2015.

Although the Customer Deposits account registered a persistently positive trend, its increase was not large enough to fuel the targeted leverage in the Asset side of the balance sheet. As a result, the average Portuguese bank held a continuously worsening position as net borrower to Central Banks and Other Credit Institutions on all the years of the sample. This drastic variation came as the result of the need to access ECB's funding to fuel the economy and meet sovereign duties, as the majority of other investors had negatively re-accessed their willingness to expose their capital to the Portuguese structural imbalances and sovereign risk, therefore quoting an unbearable risk premium.

According to the representative Portuguese bank constructed, loans to customers increased by roughly 34% from 2005 to 2010. In turn, the Loans-to-Deposits ratio that Portuguese banks registered until 2011 was the highest in Europe. The typical Portuguese bank registered its peak of 157.95% in 2007[3]. As plotted on the Chart 2 below, the Euro Area

[2] Comparing to data from the German banking industry, the homologous growth was of about 34%.
[3] It is important to note that there is a significant discrepancy among institutions with regards to this indicator. From the 4 banks that recorded the highest values for LTD ratio – which reached the peak of 180.1% - 2 of them failed to resist and were forced to close its operations.

peers followed a much smoother approach with regards to this ratio, registering a peak of 139.2% in 2007[4].

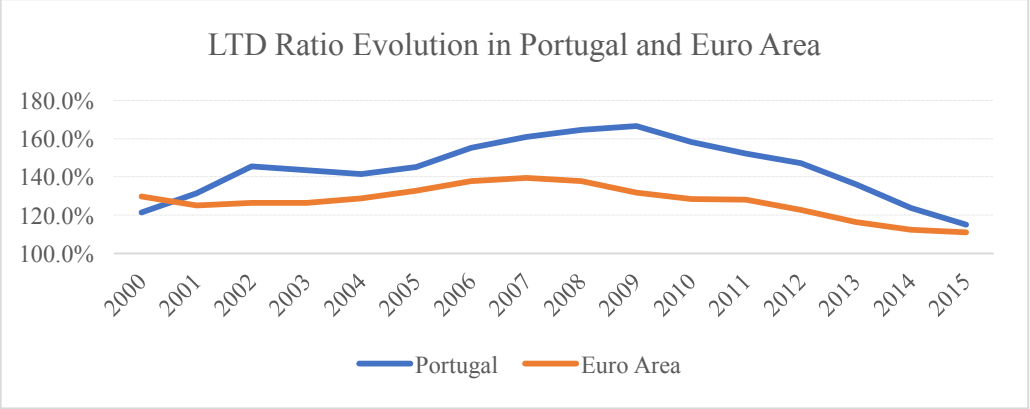

Chart 2 - Evolution of LTD ratio in the Portuguese and German Banking Industry from 2005 to 2015.

As illustrated in Chart 3 below, in terms of profitability, the years that preceded the international financial crisis registered an exceptionally high Return on Equity (ROE), which gradually fell until 2011 – the moment when breached the negative barrier.

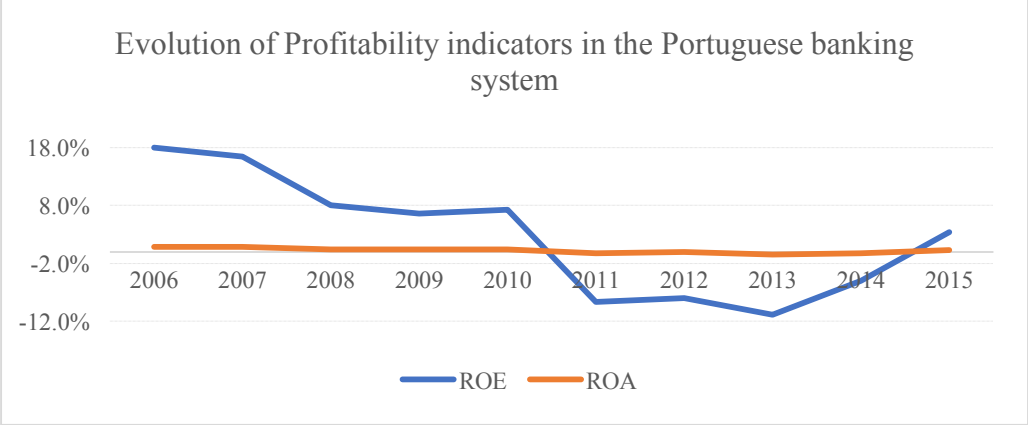

Chart 3 - Evolution of profitability indicators in the Portuguese banking system from 2006 to 2015

3.2. The Financial Crisis: Repercussions and Adjustments

The adverse international macroeconomic context, the implementation of the needed adjustments to rebalance the Portuguese sovereign debt crisis and the aggravating difficulties

[4] Data collected from ECB statistics database.

that the Portuguese State, its companies and banks faced when trying to access external funding at bearable costs translated into an economic recession.

As it is possible to observe in the previously presented Chart 1, the Portuguese GDP suffered volatile changes from the period of 2007 until 2012, decreasing its annual growth rate by about 6.5%. The substantial cuts in public spending contributed to boost unemployment, which spiked to 17.5%[5].

On the banking spectrum, institutions were forced to de-leverage their portfolios quite rapidly in an attempt to regain investors' trust. Therefore, the balance sheet of these financial institutions experienced significant structural changes. For the representative portfolio of a Portuguese bank, total assets decreased by 21% from 2010 until 2015. In contrast, on the Euro Area, the same account shrank by about 2.4%[6].

On the Liabilities' side of the balance sheet, it was crucial to control the previously registered dependence from wholesale funding, which until 2012 increased at a much faster rate in Portugal compared to its Euro Area' peers. On that basis, from May 2011 to September 2016, the growth rate of usage of this funding source decreased by about 8.1%, while the Euro Area peers registered a reduction of roughly 3.3%.

In the context of the significant difficulties in accessing the Interbank market – and the latter drying up of funds – brought by the sovereign crisis, the funding from the ECB rapidly increased until 2012, as it is possible to see from Chart 4 below[7]. This account's growth from 2008 until May 2011 reached 362.3%.

Since 2010, loans to customers shrank approximately by 22.8%, which supported the crucial reduction in the LTD ratio. The latter decreased by 36.1% during the same period, staying at 114.8% in 2015 (as illustrated in Chart 2).

[5] Data collected from Eurostat.
[6] According to data published by the Portuguese Banking Association.
[7] Data was gathered from the Portuguese Banking Association.

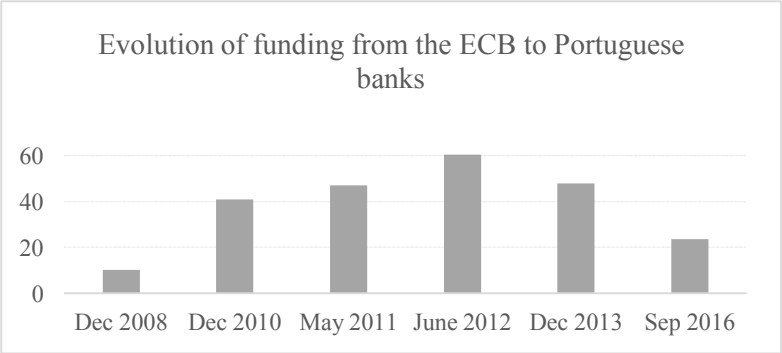

Chart 4 - Evolution of funding from the ECB to Portuguese banks (data in thousands of millions of Euros).

Additionally, the solid behaviour of Total Deposits was also contributing for a smoother adjustment in this indicator, which, despite the overall crisis context, increased by 7.1% from 2010 until 2016. This positive trend was supported by the low business environment and lack of trust that led individuals and companies to diminish their consumption and delay their investments, thus boosting savings.

With regards to the efficiency across the industry - measured by the cost-to-income –, it suffered a fall of about 18%[8]. This decrease is justified by the impacts of the Non Performing Loans (NPL) in the operating income. Furthermore, factors such as the creation of the internal means to monitor and guarantee the compliance with the new regulatory requirements also played a role in the surge in costs associated with the business.

As far as Net Interest Income (NII) (as a percentage of assets) is concerned, it suffered a significant decrease from the period of 2008 to 2013. In general, the negative interest rate environment created a negative pressure on banks profitability, boosted by the intervention of the ECB. Combined with the context of low economic growth, this limits the amount of income-generating opportunities. Moreover, the reputational risks arising from the perceived underlying risk of the country and its institutions also deteriorated NII.

[8] According to the data from the 7 Portuguese banks considered in the study, it was in 2007 when the efficiency indicators achieved its highest performance.

As previously mentioned, and clearly illustrated in Chart 3, profitability indicators were severely harmed. In part, this poor performance was boosted by the increases in capital that most banks undertook in an attempt to strengthen their balance sheets.

In conclusion, in Table 1 below, it is possible to find the evolution of some of bank's KPI's from 2007 to 2015.

	Total Assets	Equity	Total Liabilities	ROE	ROA	Net Interest Income	Cost-to-Income
2007	70334.801	4066.348	66268.453	16.51%	0.85%	1.68%	53.41%
2008	75670.689	4220.470	71450.219	8.00%	0.44%	1.72%	55.80%
2009	80445.802	4860.621	75585.181	6.63%	0.42%	1.37%	57.94%
2010	83558.204	5191.520	78366.684	7.32%	0.42%	1.36%	56.82%
2011	79054.784	3681.455	75373.329	-8.65%	-0.22%	1.42%	59.93%
2012	76753.618	4221.441	72532.177	-8.02%	-0.01%	1.35%	56.70%
2013	70923.322	3363.685	67559.637	-10.88%	-0.48%	0.99%	71.73%
2014	68205.305	2702.062	65503.243	-5.07%	-0.21%	1.09%	62.91%
2015	70659.808	3072.076	67587.731	3.43%	0.28%	1.34%	58.36%

Table 1 – Evolution of KPI's for the representative Portuguese bank, from 2007 to 2015. Data in Millions of Euros.

4 Defining and measuring liquidity

As discussed in Tirole (2011), liquidity risk can arise from several different sources and, therefore, it is a concept that should not be analysed solely through an unique perspective. As previously mentioned, it can be defined as the risk of losing access to funding, whether by failing to capture deposits or inability to refinance the current outstanding positions.

As considered by Bonfim and Kim (2012), three of the different possible approaches to measure and quantify this concept can be the Interbank Ratio – given by the Interbank Assets as a percentage of Interbank Liabilities -, the Liquidity Ratio – expressed by the liquid assets as a percentage of customer deposits and short-term funding – and the Loans to Deposits ratio (LTD). Moreover, an analysis of the funding gap and the maturity mismatch between assets and liabilities is also critical to comprehend the fragilities of the cash-flow management of an institution.

Given that the objective of this study is to develop a methodology to identify the key factors that shape Portuguese bank's liquidity strategies both at an individual and collective scope, it is crucial to guarantee that there is consistent reporting and clarity in the data

available for each bank at each year. Unfortunately, since the reporting organization across different banks and, sometimes, within the same bank over the years, is not constant, it can become difficult to efficiently isolate certain accounts. For this reason, the Liquidity Ratio and the funding gap were excluded from the analysis.

In regards to the Interbank Ratio – measuring the net position of each bank with other Central Banks and Credit Institutions –, it is closely tied with liquidity risk since it is frequently associated with short maturities, creating room for complications in the case of need to roll over their obligations. In the light of the financial aid that the Portuguese State and banks received during the sovereign crisis and the drying of funds resulting from the market turbulence registered in 2007, the accounts that compose this ratio have been severely affected. For example, and as previously mentioned, there was a surge of 362.3% in funding received from the ECB, which reads as a worsening of the net borrowing position. However, the underlying reasons behind this variation are not directly related to an increase in risk taking in terms of liquidity. Therefore, for the purpose of this study, this measure may not, by itself, provide the cleanest approach to the evolution of liquidity risk policies.

Against this background, the LTD ratio is the most suitable and complete measure to address the objectives of this study. This indicator is calculated by dividing the Total Loans to Costumers[9] by the Costumer Deposits[10] for each institution, for each year. By providing the relationship between a largely solid source of funding – the customer deposits – and its transformation into credit, it allows to understand to which extent banks were stepping apart from this more stable source of funding to leverage their provision of resources. The higher the dependence on wholesale funding, the more the bank is exposed to market's volatility and this, in turn, generates even further difficulties when rolling over their obligations in times of

[9] Which includes loans to companies, institutions, project finance, mortgage loans and loans to individuals.
[10] Including Sight, Term and Saving deposits.

financial distress. Finally, this inability to manage the short-term maturity of the liabilities and the long-term maturity of its assets drives the bank into an illiquid state.

In fact, and just as studied in the previous sections, this ratio's behaviour was a good representation of the imbalances of the pre-crisis period and the following adjustments. Additionally, its computation is fairly easy and its components are unmistakably identified on the official reports of the studied banks.

5 Determinants of Banks Liquidity Management Decisions – Empirical Evidence

5.1. Empirical Evidence at an Individual Level

5.1.1. Data and Methodology

As it was made clear in the previous chapters of this study, the Portuguese banking crisis was, among other factors, a result of a high risk taking strategies in terms of liquidity management from the industry players. Not only the sustainability of the strategies relied, to a large extent, on an (utopic) unlimited access to wholesale funding, but also the maturity distribution of each obligation left room for deep unbalances should there be any distress environment in the global economy.

To understand to which extent certain factors contributed for determining the liquidity strategies of Portuguese banks for the periods of pre and post crisis, an econometric model using Panel Data was constructed. The data was gathered from each Annual Report and Accounts for 6 Portuguese banks: Banco Português de Investimento (BPI), Caixa Geral de Depósitos (CGD), Banco Espírito Santo (BES), Banco Comercial Português (BCP), Banco de Investimento do Funchal (Banif) and Montepio. For this part of the study, Crédito Agrícola was not included due to its different policies in regards to its liquidity management (a much more conservative approach). The maximum value this institution reached in terms of its LTD ratio during the period of the sample was of 86.88%, while simultaneously other banks

were registering 192%. It is not considered, therefore, a representative case of how liquidity risk was being managed in the Portuguese banking industry.

The study will be separated in two perspectives. Firstly, a model analysing the determinants to measure liquidity risk at an individual (micro) level was constructed. For this purpose, the following variables for each institution were considered:

Variable Name	Description	Expected Relationship
	Dependent Variable	
LTD ratio *(ltd)*	Loans-to-Deposits ratio for each institution at each given year	
	Bank Characteristics	
Size *(assetstotal)*	Measured by each bank Total Assets for each period	Positive, since banks that hold more assets would have higher incentives to pursuit riskier liquidity strategies based on the belief that these assets constitute a more solid buffer.
Profitability *(roa, roe, nii)*	Measured by each bank's ROA, ROE and NII for each period	Positive, based on the premise that banks that recorded decent levels of profitability in the previous periods would continue on undertaking strategies that would increase exposure to liquidity risk.
Efficiency *(ci)*	Measured by each bank's CI	Negative, following the proposition that institutions whose efficiency indicators have showed good performance will continue on leveraging their balance sheets.
Profile *(loanstoassets)*	Measured by relationship between each bank's total assets and total customer loans	Positive, since banks that are more specialized in lending can be associated with a deeper net borrowing position and more vulnerable funding structures, being more exposed to liquidity risk.

Variable Name	Description	Expected Relationship
	Market Conditions	
Economic Performance *(gdpgrowth)*	Measured by GDP Growth for each considered period	i) If previous period GDP showed signs of solid growth, there are incentives to believe in sustainability of current practices, therefore the relationship would be positive; ii) Poor GDP growth in previous period may indicate low interest rate environment, which may boost leverage by turning it into a relatively cheaper strategy.
Euribor *(euribor)*	Measured by the average 1-year Euribor rates for each studied period	Negative, based on the fact that the lower the interbank funding rate is, the cheaper it would be to continue on fuelling the previous leverage practices.
	Time Controls	
Time trend *(timetrend)*	Variable that considers the passage of periods in the sample	The goal is to understand whether the de-leveraging followed a smoother pattern or if, instead, the adjustments were more sudden. Intuitively, it would be to expect that this variable would be negatively correlated with a riskier attitude towards liquidity. One of looks to analyse the impact of the international liquidity crisis from 2007 to 2009, the other focus on the impact of the sovereign crisis in Portugal (2010 to 2015).
International Crisis *(intcrisis)*	Dummy variable for being in the period from 2007 to 2009	
Portuguese Crisis *(sovcrisis)*	Dummy variable for being in the period from 2010 to 2015	

5.2.1. Econometric Treatment

Problems of endogeneity may be associated with the explanatory variables used, which may possibly harm the econometric accuracy and unbiasedness of the estimators. The fact that the model is conducted with the lagged values for each independent variable allows to minimize the effect of simultaneity as a source of endogeneity.

Both the Hausman and the Breusch-Pagan LM tests were computed, confirming the presence of fixed effects in the sample. Hence, the final regressions were calculated following a fixed-effect model. This specification allows to control for each bank's individual own characteristics (not considered in the data, such as, for instance, bank's culture) that do not vary over time and that may influence the predictor variables.

Additionally, using the Variance Inflator Factor (VIF) command in Stata, it was concluded that the models are not affected by collinearity.

Finally, to correct for the heteroskedasticity detected in the sample and to guarantee the efficiency of the estimated parameters, robust standard errors were used.

5.1.2. Empirical results

After correcting for the econometric issues on the sample and empirically analysing which variables were statistically meaningful (considering a confidence level of 90%) to determine banks' choices on their liquidity management, the final model was achieved comprising the characteristics at bank level and is as follows:

$$LTD_{i,t} = \beta_0 + \beta_1 Cost\ to\ income_{i,t-1} + \beta_2 Total\ Assets_{i,t-1} + \beta_3 ROE_{i,t-1} + \beta_4 Sovereign\ Crisis + \alpha_i + \mu_{i,t} \quad (1)$$

The results from the estimation of Equation 1 are presented in Table 2.

From the interpretation of the table, one can conclude that, considering a 90% confidence interval, the individual factors that contribute the most to define the banks' liquidity strategy are the efficiency performance verified of the previous year, the size of the bank measured by the assets it held at *t-1*, its previous profitability and, finally, the fact that Portugal was facing a sovereign debt crisis. The most pronounced effect on the LTD of each institution is shown to be the economic downturn of the country – accounting itself with a decrease of 32.1% in the LTD, on average, ceteris paribus.

Moreover, profitability and efficiency also play a significant role. A surge of 1 percentage point in the ROE provides, on average, an incentive of about 0.46 percentage points towards a riskier liquidity strategy. On the other hand, a marginal increase in the CI (which translates in a loss in efficiency) influences the institution into a more conservative approach to risk, causing a decrease of about 0.28 percentage points in the LTD, on average, ceteris paribus.

REGRESSION ON INDIVUAL CHARACTERISTICS			
	Loans to Deposits Ratio		
	i, t		**t-statistics**
	(1)		(2)
Cost-to-Income *i, t-1*	-0.284	***	
			-2.220
Total Assets *i, t-1*	0.011	**	
			5.790
ROE *i, t-1*	0.464	*	
			2.240
Sovereign Crisis	-0.322	***	
			-6.610
Number of Observatio	62		
Number of Groups	6		
R2 within	0.692		
R2 between	0.000		
R2 overall	0.098		

Sources: Report and Accounts; author calculations.
Notes: *** significant at 1%; ** significant at 5%; * significant at 10%. Column 1 and 2 represent the parameters and t-statistics associated with each variable, respectively.

Table 2 - Results from econometric regression based on individual factors.

Finally, there is also evidence that positively correlates the size of banks with a more aggressive liquidity risk management policy. The findings suggest that an increase of 1000 million euros will, on average, be associated with a rise of 1% in the LTD.

In terms of goodness of fit, it is concluded that 69.1% of the variations on the dependent variable across time are explained by the variations in the explanatory variables.

5.2. Empirical Evidence at a Collective Level

To investigate the hypothesis that Portuguese banks internalize its peers' position towards risk in their own liquidity risk management - generating a collective risk taking practice - two approaches were followed. Firstly, a new econometric regression considering an additional variable was computed. Secondly, a LSV method was constructed.

5.2.1. Econometric Model - Data and Methodology

In order to comprehend whether there is, indeed, propensity for collective risk taking among banks, a new variable was introduced. LTD Peers for each bank *i* at time *t*, is a weighted average (based on the proportion of all the other banks' assets to the total industry assets, adjusting to the absence of bank *i*) of LTD ratio. The main objective is to analyse the impact of the choices of the peers at time *t-1*, when bank *i* is optimizing its own strategies at time t. A second econometric regression was ran, including both individual and collective variables.

5.2.2. Econometric Treatment

The same econometric treatment applied to the individual-based characteristics model (based on individual characteristics) was conducted in the present regression.

Including the variable LTD Peers at *t-1* may generate issues of reverse causality. As discussed in Manci (1993), the problem arises from the fact that it is not possible to guarantee that the decisions of bank *i* across time do not influence the strategies of other banks in the

peer group as well – there are omitted time-invariant variables across banks that affect the independent variable.

5.2.3. Econometric Model - Empirical results

After correcting for the econometric issues on the sample and empirically analysing which variables were statistically meaningful (considering a confidence level of 90%) to determine banks' choices on their liquidity management, the final model was achieved comprising the individual characteristics of each institutions and is as follows:

$$LTD_{i,t} = \beta_0 + \beta_1 LTD\ Peers_{t-1,j\neq i} + \beta_2 Total\ Assets_{\ i,t-1} + \beta_3 ROE_{i,t-1,} + \beta_4 Sovereign\ Crisis + \alpha_i + \mu_{i,t} \quad (2)$$

According to the Table 3, and continuing on considering a confidence interval of 90%, the previously used lagged explanatory variables ROE and Total Assets remain statistical significant and consistent with the previously presented signals. However, the introduction of the variable accounting for the peers' effects changed the magnitude of its impact on the LTD ratio. In this new regression, the fact that the institution is operating in a year of sovereign crisis in Portugal decreases its impact on LTD ratio to about 19.5%, on average, ceteris paribus (compared to the 32.1% previously registered). Moreover, a marginal rise of 1000 million euros in terms of Total Assets will cause the institution to increase its LTD by about 0.4%, an impact lower than the previously registered. Finally, profitability experienced a marginal increase in the magnitude of its impact, adding an average of 0.47 percentage points to the LTD ratio for each marginal increase in the ROE. With the introduction of the new variable, the efficiency factor lost its previous statistical significance.

Based on the findings, it is in fact possible to confirm that there is statistical significant evidence of herding among the Portuguese banks in terms of liquidity management. On

average, when there is an increase of 1 percentage point in the peer's LTD, bank *i* is likely to increase its own LTD by an average of 0.49 percentage points.

The goodness of fit of this econometric regression shows that 76.14% of the variations in the LTD at time t are explained by variations in the used independent variables.

REGRESSION ON INDIVUAL AND PEERS CHARACTERISTICS				
	Loans to Deposits Ratio *i, t*	**t-statistics**	**Loans to Deposits Ratio *i, t***	**t-statistics**
	(1)	(2)	(1)	(2)
Cost-to-Income *t-1*	-0.284 ***		-	
	-2.220	*-2.220*	-	
Total Assets *t-1*	0.011 **		0.005 **	
		5.790	2.880	
ROE *t-1*	0.464 *		0.472 *	
	2.240	*2.240*	2.260	
Sovereign Crisis	-0.322 ***		-0.195 **	
	-6.610	*-6.610*	-3.380	
Peers Loans-to-Deposits *t-1*	-	-	0.492 ***	
			6.09	
Number of Observations	62		57	
Number of Groups	6		6	
R2 within	0.692		0.761	
R2 between	0.000		0.000	
R2 overall	0.098		0.327	

Sources: Report and Accounts for each institution; author calculations.
Notes: *** significant at 1%; ** significant at 5%; * significant at 10%. Column 1 and 2 represent the parameters and t-statistics associated with each variable, respectively.

Table 3 - Results from econometric regression based on both individual and collective factors.

Comparing the results achieved for the two models, it is possible to conclude that, when accounting for the variable that reflects the peers' decisions towards its LTD ratio, the goodness of fit of the overall regression increases.

5.3. LSV measure – Statistical Evidence for Herding in the Banking Industry

The LSV measure, firstly proposed by Lakonishok, Sheifer and Vishny (1992), is an indicator initially built to identify herding strategies among investors in the financial markets. The propensity to mimic other player's behaviour independently of the fundamental value of the strategy may significantly bias financial instruments' prices due to the excessive concentration of transactions. This measure's applicability in the banking industry was further explored by Uchida and Nakagawa (2007) and Van den End and Tabbae (2012).

5.3.1. LSV measure – Data and Methodology

Under the null hypothesis that there is no herding in liquidity risk management – meaning that agents optimize their attitude towards risk in a given period for reasons that are only related to its own intrinsic performance and the overall economic context – the following Equation 3 was computed:

$$H_i = |P_i - P_t| - E|P_i - P_t| \quad (3)$$

Where *Pi* is given by the number of banks that increased their LTD ratio from period *t-1* to *t* divided by the total number of banks active in that period. *Pt* represents the mean of *Pi*'s for all the periods of the sample. The latter variable can, therefore, be considered as a proxy for what is the unbiased rational behaviour under the general macroeconomic conditions affecting the sector. To construct this variable, a yearly average of the LTD ratio from all the Euro Zone countries was computed[11].

In regards to the Adjustment Factor in the equation – important in order to normalize the measure, guaranteeing that is has zero mean under the null hypothesis -, it was achieved by computing the sample average of $|P_i - P_t|$ across time.

[11] As previously analysed on Chart 2, other Euro Zone' banks did not undertake the same leverage on their LTD ratio. In general, most countries kept this indicator well below the Portuguese one.

To test whether there is evidence for herding behaviour in liquidity risk management across banks, a t-statistic was computed and compared against the relevant critical values.

5.3.2. LSV measure – Empirical results

The findings of the application of the LSV measure to Portuguese baking data from 2005 to 2015 is presented below on Table 4.

As it possible to see, evidence supports the existence of persistent herding behaviour across peers with regards to their liquidity choices. It is in fact true that departing from 2011 – period where it was statistically proved in the previous session that was significant in affecting liquidity risk management – the needed adjustments common across all banks in the sample could possibly be influencing the results. However, before this period, there is no fundamental reason that could support such collective risk taking behaviour.

Year	Pi	Pt	Pi-Pl	Hi	t-stat	At 95% CI	At 90% CI
2005	1.000	0.235	0.765	0.257	9.204	Herding Evidence	Herding Evidence
2006	0.667	0.353	0.314	-0.194	4.731	Herding Evidence	Herding Evidence
2007	0.500	0.353	0.147	-0.361	2.203	No Herding Evidence	Herding Evidence
2008	0.500	0.833	0.333	-0.174	2.864	Herding Evidence	Herding Evidence
2009	0.667	0.833	0.167	-0.341	1.772	No Herding Evidence	Herding Evidence
2010	0.167	0.579	0.412	-0.095	6.205	Herding Evidence	Herding Evidence
2011	0.000	0.789	0.789	0.282	14.058	Herding Evidence	Herding Evidence
2012	0.000	0.789	0.789	0.282	17.647	Herding Evidence	Herding Evidence
2013	0.000	0.737	0.737	0.229	15.879	Herding Evidence	Herding Evidence
2014	0.000	0.789	0.789	0.282	17.227	Herding Evidence	Herding Evidence
2015	0.500	0.842	0.342	-0.166	5.503	Herding Evidence	Herding Evidence

Table 1 - Results from the application of the LSV measure for herding to Portuguese banks.

5.4. Limitations of the models used

There are a few limitations associated with the proposed methods. Firstly, the Portuguese banking system is rather small when compared to other economies. Therefore, only 6 institutions were studied across 11 years, which provides a rather small sample that might possibly harm the econometric accuracy of the parameters. Moreover, since the data was gathered from the Report and Accounts of each bank, the availability of older data was

limited. Using a more complete dataset, two econometric regressions would have allowed a more detailed study of the evolution of the risk management decisions and the changes in the magnitude of each regressor on liquidity risk. To respond to this limitation, the dummy variables International Crisis and Sovereign Crisis were added in order to isolate the effect of the economic cycle in which the liquidity management takes place.

In addition to this, other variables would have been relevant to understand liquidity strategies, as for example the funding gaps and maturity mismatches of each institution. In fact, by analysing the data provided by a few banks, it is possible to verify that the 1 year funding gap showed a constant negative net position, reaching its worse performance in 2010. However, due to differences in reporting across banks and, sometimes, the lack of consistency in the patterns of published information for the same institution across time, such variable was not used.

Using the ROE as a measure of profitability may also be misleading. As discussed on the ECB study *"Beyond ROE – How to Measure Bank Performance",* the possibility of articulating this indicator through changes in the equity of the institution affects its reliability. According to this study, there is empirical evidence of a greater dispersion of capital ratios during the period of the crisis due to this possibility artificial modification[12]. Thus, a time series comparison becomes challenging[13]. Despite these drawbacks, the ROE tends to be one the most looked-at indicators of profitability in the investors' perspective. Against this background, even if managers realize the limitations of this indicator, it is understandable to consider it as a key indicator to consider when defining their strategies.

Finally, the LSV approach also entails some restraints. One of the main drawbacks of this methodology is the fact that it does not distinguish intentional herding. As discussed by

[12] Based on the finding of the study, there is indeed empirical evidence that points to the link between the most profitable banks - measured by roe – being the ones who were hit the most by the crisis.
[13] In fact, based on the representative approach created along this study, the ROE of a typical Portuguese bank dramatically decrease by about 16% from 2010 to 2011.

Frey, Herbst and Walter (2007), it is possible to argue that the measure is not able to fully identify and separate situations where players are, in fact, intentionally herding, and when this concentration of decisions arises because peers are facing the same information set.

6 Conclusions

This study provides empirical evidence on the determinants of the strategic approach to liquidity risk management in Portuguese banks and addresses the issue of herding in liquidity risk in the years that precede the Portuguese sovereign crisis. All in all, both the econometric approach and the LSV measure implemented provide meaningful statistical evidence of collective risk taking within the industry. From the results and analyses above mentioned, it is possible to conclude that individual players have defined their strategies not only taking into account and weighting their own intrinsic characteristics, but also closely monitoring what other players were doing in order to take insights to adjust their own business.

As discussed in Farhi and Tirole (2012), and according to these authors, this identified evidence for herding in the banking industry tends to be built upon the idea that the lender of last resort – institutions regulating the industry – will not allow a collective failure within the banking system as the damage and societal harming would be perceived as too destructive. Therefore, banks followed a continuously-leveraging strategy, underestimating the downside risks and holding on to the belief that in the (unlikely) event of losses, these would be absorbed by these entities whose goal, above anything else, is to ensure market stability (IMF; ECB; others). Such belief shared by the generality of the industry players generated a self-fulfilling prophecy translated in increasing risk-taking behaviours.

Only when money markets and investors' confidence were shaken by the events of 2007-2009 (Lehman Brothers failure; drying of funds in the Interbank market), the misperception of real risk of these strategies was exposed. The severe consequences surpassed the financial system spectrum, dramatically affecting the real economy. The

Portuguese banking system, scoring the highest in the LTD ratio when compared to its European peers, experienced to the fullest this dramatic environment while simultaneously dealing with a severe sovereign crisis, which aggravated even further the risk premium charged to national banks.

This enlarged leverage clearly surpassed the optimal point. As discussed in the previous sessions of this study, the years preceding the crisis were shaped by steep increases of the LTD ratio. However, the agent's measures of profitability (ROA/ROE) were no longer indicating a better performance – the decision of engaging in a marginal increase in liquidity risk was not yielding the needed additional return to support it. This setting reinforces even further the empirical evidence found in favour of herding behaviours and, in the light of the drawback of the LSV model of not being able to separate intentional herding, is key to exemplify how, if the optimisation of the strategies were made individually, the outcome would differ.

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